Location

The Dinero Tunnel is located within Sugarloaf Gulch, a tributary to the Lake Fork. The Lake Fork is located on the east side of the Sawatch Range in the Colorado Rocky Mountains at the upper reaches of the Arkansas River valley. The Lake Fork watershed comprises approximately 75 square miles near the San Isabel National Forest on the east side of the Continental Divide. The Lake Fork flows for approximately 4.5 miles from Sugarloaf Gulch until its confluence with the Arkansas River.

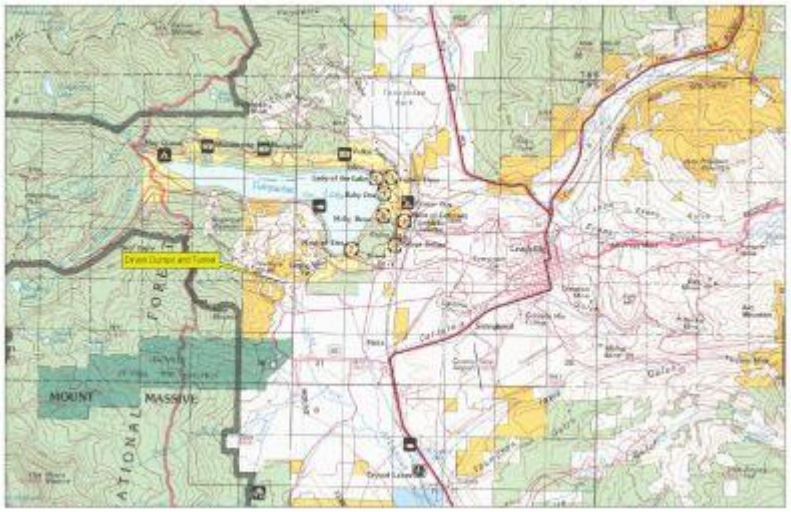
In 2000 the BLM formed a pro-active stakeholder group, called the Lake Fork Watershed Working Group, to address water quality issues within the Lake Fork. The stakeholder group includes representatives from Colorado Mountain College; federal agencies including: US Fish and Wildlife Service, Bureau of Reclamation, Environmental Protection Agency, US Forest Service, BLM – National Science and Technology Center, US Geological Survey – Water Quality Division, Colorado Department of Public Health and Environment, Colorado Division of Reclamation, Mining, and Safety, Colorado Division of Wildlife, Lake County, and private landowners in the area. This partnership has been working in cooperation for several years and this project is an outgrowth of that partnership.

The Dinero Tunnel is located on a patented mining claim in private ownership. The site is being pursued for cleanup due to significant downstream impacts to federal lands and waters. The affected area immediately downstream includes a wet meadow/beaver pond complex with noticeably absent aquatic insects and fish. This wetland is supported by other surface and ground water flow and a riparian area along Lake Fork Creek. Approximately 15 acres of these biotic resources will be remediated through implementation of this decision. More substantial will be the enhancements to the Lake Fork, which has significant damage to fish populations primarily due to toxic concentrations of zinc, iron, and manganese in discharge from the Dinero Tunnel.

The site is located within Sugarloaf Gulch and is one of many tributaries to the Lake Fork Creek that converge with the upper Arkansas River about 3 miles below the Dinero Tunnel. The Dinero Tunnel site is comprised of the Dinero Tunnel (a flowing adit) and a series of limestone lined channels and settling ponds that receive acidic mine drainage from the adit. The Dinero Tunnel is connected to the Dinero shaft and other mine workings, located 3,500 feet southwest of the tunnel portal. Acidic mine drainage flows out of the tunnel from 32 gallons per minute to 220 gallons per minute with higher flows in the spring and early summer.

The Dinero Tunnel was constructed as a dewatering tunnel for Sugarloaf Mountain. Dewatering of the mountain by the Dinero Tunnel allowed access via the Dinero Shaft to previously flooded portions of the Dinero Vein. The mine workings extend for over 3,300 ft towards the northwest where it eventually intersects the Dinero Mine Shaft and the Dinero Vein. It was reported in mine inspector records that the Dinero Mine Shaft encountered water at 300 ft below ground surface which was the probable original ground water level.

Surrounding land use includes BLM, USFS, and privately owned land. Both developed and undeveloped campgrounds are found along the Lake Fork, and three private summer homes are located about a quarter of a mile west of the site. Irrigation water is diverted from the Lake Fork of the Arkansas a few hundred feet below the Dinero Wetlands Area. The majority of the surrounding lands are undeveloped and forested. The town of Leadville, Colorado, is located approximately five miles east of the site.



Location map of Dinero dumps and tunnel reclamation projects

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Problem

The area of the Arkansas River from Lake Fork to Lake Creek, including the Lake Fork watershed, is classified by the Colorado Water Quality Control Commission as aquatic life 1, recreation 1a, and water supply and agriculture uses. However these areas do not meet these goals and uses and do not meet Colorado water quality standards for several metals. Therefore, the area has been identified by the Colorado Department of Public Health and the Environment as a Clean Water Act Section 303(d) impaired water body. In addition, the Lake Fork watershed was identified as a contributory source of concern in the Lake County Clean Water Act Section 208 Inventory and Assessment (CMC 2004). The Arkansas River is a source of potable water for Front Range areas including Aurora, Colorado Springs, and Pueblo Colorado (EECA, 2003).

Within the Lake Fork and the upper reaches of the Arkansas River manganese and zinc are found to exceed Colorado water quality standards. All previous investigations and studies over a 15-year period have documented that the Dinero Tunnel is the single worst offender in the entire Sugarloaf Mining District, particularly with reference to zinc. Zinc, the metal most toxic to aquatic life, has exceedances of water quality standards up to 230 fold below the Dinero Tunnel. Acidic mine drainage emanating from the Dinero Tunnel is adversely impacting public lands and water downstream. Contaminants of concern for the site include aluminum, iron, manganese, and zinc along with periodic slight releases of cadmium and copper. Of these metals iron, manganese and zinc are the most elevated in the acidic mine drainage, manganese and zinc are elevated in Lake Fork, while iron is retained within the Dinero wetland.

There is a significant risk to aquatic life, as indicated by toxicity studies and by the standards comparison. The Dinero Tunnel and Sugarloaf Gulch are significantly loading toxic metals to the wetland and the Lake Fork. Of particular concern are iron, manganese, and zinc concentrations that repeatedly occur above thresholds protective of aquatic life. Effects from loss of habitat and food supply would be expected to species feeding in the aquatic food chain such as insects, fish, waterfowl, and riparian birds and mammals. Currently, toxicity to aquatic life in Lake Fork is caused primarily by zinc because iron is retained in the wetland and manganese is much less toxic to aquatic life.

There are 34 total acres of impacted riparian habitat immediately below the Dinero Tunnel that have

been a recipient of acidic mine drainage. This habitat includes wetlands and a fen with the wetlands heavily loaded with substantial quantities of iron, zinc, manganese and other metals. The wetlands have in particular retained iron and manganese. Today fish and insects are noticeably absent from these impaired wetlands.

There is a concern both for the environment and for human health. From a human health standpoint the concerns are for recreational users in the area such as hikers, campers, and fishermen that may come into direct contact and possibly ingest contaminated water, sediment, and fish located in Sugarloaf Gulch and Lake Fork. There are also residents who live within a quarter mile of the Dinero Tunnel area. Water from Lake Fork a short distance below the Dinero Wetlands is also diverted into an irrigation ditch and utilized for watering meadows grazed by cattle.

Human health risk from the water medium is evaluated by the comparison of Sugarloaf Gulch and Lake Fork water quality to EPA maximum contaminant levels (MCLs) for human health protection.

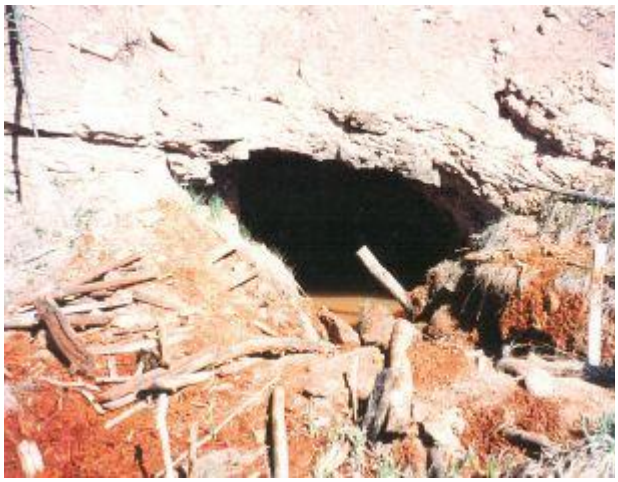
- Exceedances of secondary MCLs of aluminum, copper, iron, manganese, and zinc are quite frequent and generally large. Acidic mine drainage characterization conducted by BLM personnel in 2006, reports metals concentrations ranging from 14.2 to 19.8 mg/L of iron, 39.5 to 43.9 mg/L of manganese, and 12.1 to 14.6 mg/L zinc.
- Exceedances of primary MCLs of arsenic, cadmium, lead, and selenium are few and generally low.
- The Colorado water supply dissolved standard for manganese is 50 µg/L for this drainage (based on aesthetics for taste and staining), and indicates that manganese is of concern although there is no use of Sugarloaf Gulch and Lake Fork for water supply in this area. These secondary MCLs are based on taste and aesthetic values, and do not reflect significant risk to human health.

Currently the amount of acidic mine drainage does not vary considerably in quantity or quality over time. A significant concern would be a tunnel blow out. Blow outs occur when acidic mine drainage sludge builds up or cave-ins build up and block flow. A pressure head develops behind the sludge build up and when the head becomes too great it blows out the sludge barrier. The result of a blow out is a rush of sludge, rocks and acidic mine drainage which is usually released into the environment. Historic evidence of blow outs has been observed in the Dinero Tunnel. One of the primary purposes of the bulkhead would be to control blowouts in the future. Depending upon the severity of the blow out, it is possible that some of the iron and manganese stored in the wetland complex also could be picked up and moved downstream.

The key requirements for this project are Colorado water quality standards for Lake Fork, especially the zinc standard. Zinc is the metal causing toxicity to aquatic life. Another key requirement is Executive Order 11990 concerning wetlands. This order requires that, "each agency shall provide leadership and shall take action to minimize the destruction, loss or degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetlands in carrying out the agency's responsibilities." Proposed actions would restore, preserve, and enhance beneficial values of the wetland and the riparian areas along the Lake Fork resulting in a significant public benefit.

The proposed action will:

· Meet federal and state requirements pertaining to water quality and wetlands
· Reduce releases of hazardous substances to the Lake Fork watershed
· Reduce biota exposure to acidic mine drainage and
· Reduce human direct exposure to acidic mine drainage.



Dinero tunnel adit showing acidic mine drainage

Jim Herron inside dinero tunnel at 2000 feet during inventory and analysis

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Work to Date

From 2003 through 2005, the Dinero Tunnel was partially stabilized and investigated for possible sources of the acidic mine drainage. The investigation extended 1,980 feet from the tunnel portal where it encountered a large cave-in. Acidic mine drainage seeps through the cave-in, and so the primary sources of acidic mine drainage are beyond the cave-in.

In order to conduct site characterization, a collapse about 400 feet into the tunnel needed to be repaired. This collapse was visible at the surface, which is about 200 feet above the tunnel at this location.

Prior to doing any work inside the tunnel, it was decided to drill a hole immediately uphill of the collapse in order to determine the amount of water behind the tunnel collapse. We did not want to take a chance on a surge of water occurring at the time the collapse was removed.

A set of steel sets was brought in for the purpose of stabilizing the tunnel roof in the collapse area.

Once the steel sets were installed, additional roof support materials were installed and this is being inspected.

In additional to work inside the tunnel a cooperative project between Colorado Mountain College and the BLM National Science Center was conducted to determine what type of materials would work well should a sulfate reducing bioreactor be built in the future below the tunnel.

The tunnel opening was secured to prevent unauthorized entrance. Jim Herron and Kirstin Brown of the Colorado Division of Reclamation, Mining, and Safety are shown inside the tunnel.

A large sampling effort was initiated in the area around the Dinero Tunnel to determine base level water conditions. Students from Colorado Mountain College, USGS specialists and staff from the Colorado Division of Reclamtion, Mining, and Safety all participated in sample collection.

Katy Walton Day with the US Geological Survey has an onsite lab set up to do initial sample work as part of the analysis.

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Anticipated Work

1. The installation of a single steel reinforced concrete bulkhead located 1,250 feet within the Dinero Tunnel.
2. A post construction monitoring program.
3. Construction of a sulfate reducing bioreactor one to three years after completion of the bulkhead.

Bulkhead Description

Construction of a bulkhead will significantly decrease the volume of acidic mine drainage discharging from the Dinero Tunnel. This action will decrease the off-site migration of acidic mine drainage and reduce risk associated with exposure of humans and wildlife to the acidic mine drainage. The bulkhead is expected to stop a minimum of 50% up to a probable 90% of the acidic mine drainage currently discharging from the tunnel by effectively sealing the tunnel. Once the tunnel has been sealed; acidic mine drainage will back up into the mine workings to near pre-mining groundwater levels. The flooded mine workings are referred to as the "mine pool."

The bulkhead is a permanent acidic mine drainage fix or source control method much preferable and lower cost than the long term operation and maintenance commitment required for water treatment alternatives. Properly designed and constructed, bulkheads will last indefinitely, and allow groundwater to return to its original condition prior to being disrupted by mining.

The bulkhead will also eliminate the threat of acidic mine drainage tunnel blow outs. On occasion, precipitates from the acidic mine drainage build up in the tunnel and temporarily dam the flow. These dams are a weak gelatinous mass that fail suddenly and inundate the immediate area outside the

tunnel with toxic slimes hence the term, "blow out".

To prevent leakage around bulkheads through rock fractures, it is standard practice prior to bulkhead construction to drill a ring of drill holes into the rock surrounding the bulkhead location, and pressure grout through the drill holes any intersected fractures. It should be noted that the probable location for the bulkhead at 1,250 feet is un-fractured competent granite with little if any fracturing. In the unlikely event that leakage develops around the bulkhead, additional post construction grouting may be necessary. Leakage around a bulkhead and the effectiveness of additional grouting is unpredictable, and there is always some unquantifiable risk that a bulkhead will not work to expectations.

As the water backs up into the mine workings, the acidic mine drainage discharging from the tunnel will be reduced considerably. However, groundwater may appear uphill where former seeps and springs existed that dried up or partially dried up after the tunnel was built. These renewed springs are expected to have good water quality due to the following factors:

- Mine pools becomes anoxic (oxygen deficient) which removes the major component in the acidic mine drainage chemical reaction. Simply stated, water no longer flows through the mine workings at a rapid pace, leaching out metals in an oxidizing environment.
- Metals generated in the upper portion of a mine pool tend to migrate (through small differences in water density) to the bottom. This mine pool "stratification" results in settlement of the metals and helps to remove acidic mine drainage from release.
- Groundwater tends to move along its surface, and if the mine pool backs up to the original groundwater table the rock will be more oxidized with significantly less remaining sulfide minerals. Movement of any water will occur largely above the original ore zones.

In order to gain a complete understanding of current surface water quality in the Dinero Tunnel area, a detailed baseline monitoring program was instituted by the US Geological Survey in cooperation with the Colorado School of Mines. A detailed ground survey in combination with historic record search has been conducted in the Lake Fork Watershed. As part of this monitoring program, water sampling on approximately 40 seeps, springs, and wells was completed and a report on the findings will be made available in 2008.

Preliminary results of these current sampling efforts and previous analysis completed in the Engineering Evaluation and Cost analysis indicated that there will be no significant change to the water quality of existing seeps. The current water quality of these seeps and springs is good and the water quality is not expected to change.

After the bulkhead is completed, a follow up monitoring program for ten years to analyze actual results will be completed to very bulkhead performance.

In the unlikely event that there would need to be an adjustment in mine pool water levels, the bulkhead will be equipped with a bivalve to adjust the level of the mine pool and hydrostatic pressure if necessary.

The Colorado Division of Reclamation, Mining, and Safety which has experience in managing underground construction projects of this nature, will contract out and administer construction work for the proposed action.

It is currently anticipated that the Bulkhead will be constructed in either 2008 or 2009 depending upon funding availability.

Sulfate Reducing Bioreactor

It is expected that the bulkhead will not stop 100% of the acidic mine drainage emanating from the Dinero Tunnel. It is probable that some acidic mine drainage will leak around the bulkhead l. Some of

this leakage may be remedied through additional grouting.

Remaining leakage will be dealt with through construction of a sulfate reducing bioreactor that would be constructed below the Dinero Tunnel. A one to three year monitoring period following installation of the bulkhead will allow for accurate measurements of acidic mine chemistry and volume escaping the bulkhead. Additionally there is some remaining acidic mine drainage in Sugarloaf Gulch originating from the Dinero Shaft area (several sites). This remaining water will converge just below the Dinero Tunnel offering an ideal location to construct a sulfate reducing bioreactor. The bioreactor will be constructed in the area where the former mine dumps sat in the wetlands.

It is anticipated that construction of the sulfate reducing bioreactor would commence approximately two to three years after the bulkhead installation depending upon funding availability.